Technology Collaboration Programme
by iea

International Energy Agency
Photovoltaic Power Systems Programme

FACT SHEET

Task 19 PV Integration

PVPS

PV Integration Beyond Grid Constraints

Global policy and regulatory measures

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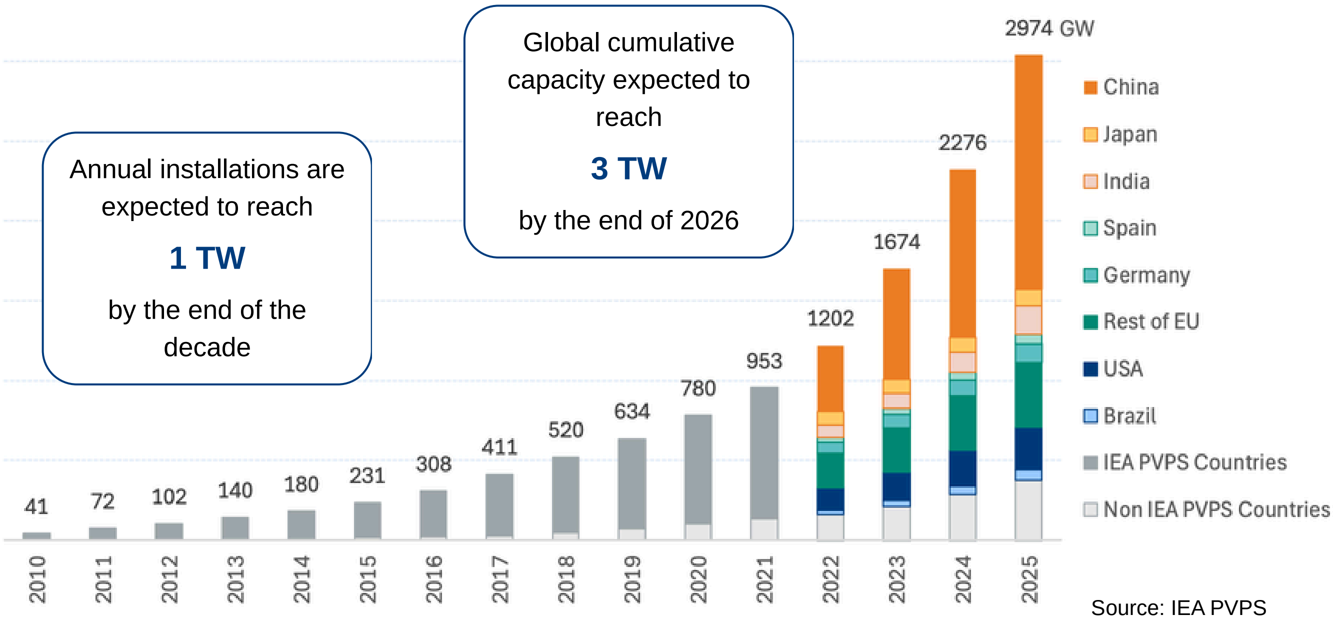
The Growing Challenge of PV Grid Integration

Solar photovoltaics (PV) are entering a new phase of deployment. As PV supplies a growing share of electricity demand, countries are increasingly facing grid and market challenges that require more flexible electricity systems. Around the world, governments and regulators are responding with new policy and regulatory measures to enable the continued expansion of PV.

Rapid Global Growth of PV Installations

Rapid PV growth is driving the transition from expanding generation capacity to integrating higher shares of renewable electricity.



Source: IEA PVPS

Key challenges emerging in many countries

Limited grid capacity

Grid infrastructure reaches its technical limits, causing connection delays and congestion.

Market impacts

High PV generation can lower electricity market prices, benefiting consumers while also reducing the market value and revenues of PV generation.

Grid and system flexibility

Higher shares of PV require greater system flexibility through storage, demand response and smarter grid operation.

System reliability

Maintaining a secure and reliable grid requires greater flexibility and system integration.

When do grid constraints become an issue?

Grid integration challenges differ depending on how PV is deployed, as well as on the characteristics of local and regional electricity networks. Countries with limited land availability and predominantly rooftop PV face different challenges from those with large utility-scale PV fleets. As a result, policy and regulatory approaches also differ.

Two broad categories of regions

Different deployment patterns lead to different integration challenges and policy approaches

Area-constrained regions

Characteristics

- Rooftop PV dominates
- Limited utility-scale PV development
- Challenges mainly at distribution
- DSO level

Common policy measures

- Dynamic electricity prices
- Per-system/area installation limits
- Smart export control (e.g. inverter clipping)
- Battery storage as an enabler
- EVs and flexible demand

Non-area-constrained regions

Characteristics

- Strong regional variation
- Large share of utility-scale PV
- Challenges at transmission (TSO) level dominate

Common policy measures

- TSO-level: ramp rates, max AC connection, mandatory storage, dynamic curtailment
- DSO-level: similar measures to area-constrained regions

Different grid conditions require different policy and regulatory approaches to enable higher shares of PV while maintaining reliable electricity systems.

How are countries enabling a higher share of PV?

Although the specific challenges differ between countries, four broad regulatory approaches are emerging to enable higher shares of PV while maintaining reliable electricity systems.

Smarter Grid Operation: Enable more PV by operating grids more dynamically, rather than relying only on fixed connection limits or grid expansion.

- **Dynamic export limits:** Adjust PV exports to available grid capacity
- **Flexible grid connections:** Connect projects faster using flexible operating conditions
- **Real-time monitoring:** Detect congestion and optimise grid operation
- **Digitalisation and distribution networks:** Simulate and plan future grid operation
- **Feeder monitoring:** Improve visibility of local distribution networks

Country Examples:

Australia: South Australia's Power Networks introduced "Flexible Exports", enabled by smart internet-connected inverters that receive regular export-limit updates matching exports to available grid capacity.

Austria: New PV systems above certain capacities must be technically designed so that grid operators can remotely control them. The Electricity Act also creates a legal framework for flexible grid connections before full grid capacity is available.

Qatar / GCC: Qatar has accelerated the adoption of export limits, DER hosting-capacity assessments and advanced inverter requirements. Digital twin and forecasting initiatives support data-driven grid integration.

Sweden: DSOs can require active power control and remote disconnection for new PV systems, while policy discussions increasingly focus on active network management and digital monitoring.

Market-based Incentives: Encourage flexible electricity generation and consumption by providing economic signals that better reflect grid conditions and system needs.

- **Dynamic electricity pricing:** Encourage electricity use when renewable generation is abundant
- **Flexible network tariffs: R**eward consumers for shifting demand away from peak periods
- **Spot market participation:** Allow PV and storage systems to respond to wholesale market prices
- **Feed-in tariff reform:** Replace fixed remuneration with more market-oriented support schemes
- **Negative price signals: I**ncentivise storage, demand response or reduced generation during periods of excess PV production

Country Examples:

Germany: New PV systems above 2 kWp no longer receive remuneration during negative spot market prices. Residential batteries and EV charging are also being integrated into the spot market.

Switzerland: The Swiss feed-in tariff system is gradually transitioning from fixed feed-in tariffs towards market-based remuneration. Future remuneration may be linked directly to spot market prices, creating stronger incentives to reduce feed-in during periods of negative electricity prices.

France: The residential PV support scheme is being reformed to reduce fixed feed-in tariffs and place greater emphasis on self-consumption and market-based remuneration.

Portugal: PV producers can participate in electricity markets and flexibility services, while regulatory reforms increasingly support energy communities and local energy sharing.

Storage & Flexibility: Increase system flexibility by shifting electricity demand and storing surplus PV generation when grid capacity or demand is limited.

- **Battery storage:** Store surplus PV electricity and release it when demand is higher
- **Hybrid PV + storage:** Combine PV plants with batteries to reduce grid stress and improve dispatchability
- **EV charging:** “Controlled charging” **-** Shift charging to periods of high (PV or other RES) generation
- **Demand response:** Encourage consumers to adapt electricity use to current grid and market conditions
- **Energy communities:** Enable local sharing and use of PV electricity
- **Aggregators:** Bundle small flexible resources and make them available to electricity markets or grid operators

Country Examples:

Italy: Grid development plans include energy storage, demand-response schemes and capacity market participation to manage congestion between renewable-rich regions in the south and demand centres in the north.

Portugal: Hybridisation of PV with wind and/or storage is increasingly promoted to optimise existing grid connection points, while residential and collective self-consumption schemes support distributed flexibility.

Spain: Regulatory proposals aim to exempt battery storage systems from network tariffs and charges for both consumption and injection, strengthening the role of storage in PV integration.

Austria: The Electricity Act creates a framework for energy communities, peer-to-peer trading, dynamic pricing and a national flexibility platform operated by grid operators.

Better Use of Existing Grids: Maximise the use of existing network capacity through shared connections, improved transparency and targeted congestion management before expanding infrastructure.

- **Hybrid grid connections:** Allow PV, wind, storage or other installations to share one grid connection
- **Shared grid connections:** Increase utilisation of existing connection points across complementary technologies
- **Grid capacity transparency:** Publish available grid capacity to guide project development
- **Anticipatory congestion management:** Identify and manage bottlenecks before they block new projects
- **Priority connection rules:** Give priority grid access to essential services or projects that provide wider system benefits

Country Examples:

Netherlands: Cable pooling allows PV and other installations, such as wind plants or electrolysers, to share grid connections. Grid capacity maps are also used to increase transparency in highly congested areas.

United Kingdom: Flexible or curtailable connections allow PV projects to connect faster and at lower cost by accepting limited export reductions instead of waiting for full grid reinforcement.

Germany: Cable pooling and stronger grid capacity transparency are being used to increase hosting capacity, while new incentives aim to direct PV investment towards less congested areas.

Conclusion

Countries are adopting a wide range of policy and regulatory measures to enable higher shares of PV while maintaining secure and reliable electricity systems. Together, these approaches demonstrate a shift towards more flexible, integrated and efficient electricity networks, supporting continued PV expansion where grid constraints and market conditions might otherwise limit growth.

About IEA PVPS Task 19

IEA PVPS Task 19 promotes the integration of grid-connected PV as a major power source by providing international studies, technical knowledge and practical guidance for stakeholders. Building on the achievements of Task 14, Task 19 addresses the technical, economic and regulatory challenges of integrating PV into electricity networks and markets, supporting grid stability, digitalisation and energy systems management. Through international collaboration, Task 19 develops the foundations for PV to become a key component of future renewable-based power systems.

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